SECTION 1
INTRODUCTION TO THE KING COUNTY DEPARTMENT OF NATURAL RESOURCES WATER QUALITY MONITORING PROGRAM

OVERVIEW

The King County Department of Natural Resources invests heavily in water quality and water quality improvements through wastewater collection and treatment. As part of an intergovernmental effort to maintain and improve Puget Sound's water quality, King County oversees regional sewerage collection, treatment process, and disposal systems which discharge wastewater to the Central Puget Sound Basin and waters flowing into the Sound.

King County's Modeling, Assessment and Analysis Unit (MAA) supports an extensive marine and freshwater monitoring program. This program assesses water quality in the Central Basin of Puget Sound (provided in this report) and of the lakes and streams within King County (provided in a separate report). Primarily focusing on areas near the County's treatment plant outfalls, the marine monitoring program verifies that effluent discharges do not degrade water quality. Monitoring is extended to areas beyond the immediate vicinity of known discharges in order to assess the background, or ambient, conditions of central Puget Sound.

While the County's marine monitoring program focuses on water quality within King County boundaries, agencies such as Washington Department of Ecology (water and sediment quality), Washington Department of Fish & Wildlife (contaminants in fish tissues), and Washington Department of Health (shellfish growing areas) also monitor water quality in Puget Sound. These agencies have stations throughout the Sound. The main difference between these programs is that the County has a larger number of stations within a concentrated area and are targeted near wastewater treatment plant discharges. Although other agencies have monitoring stations located within King County; these stations do not overlap with the County's stations which allows a greater proportion of Puget Sound to be monitored.

This report summarizes the results of King County's National Pollutant Discharge Elimination System (NPDES) and ambient marine monitoring programs for 1998. This report is intended to provide an overview of the sites monitored, the matrices (e.g., water and sediment) sampled, and provide a summary of the analytical results. Also provided is a brief overview of the sampling area and wastewater collection and treatment processes which are relevant design elements of the County's sampling program.

SAMPLING AREA CHARACTERISTICS

Puget Sound is a fjord-like estuary that extends approximately 230 kilometers (km) in a north-south direction and is bordered by the Olympic mountains to the west and the Cascade mountain range to the east. The Sound consists of four major basins, including the Main (Admiralty Inlet and the Central Basin), Whidbey, Southern, and Hood Canal basins. Whidbey Basin is not a basin in the geological sense; its southern boundary is arbitrarily chosen to be an imaginary line running from Possession Point on Whidbey Island across the channel to Meadowdale in Snohomish County. The Sound's average depth is 106 meters (m). The Main Basin, with depths of greater than 280 meters, is shielded at the main entrance to the Sound by Admiralty Inlet Sill which impedes free exchange of deep waters. However, the Sound has near-oceanic salinity throughout the year, and is supplemented with cold, nutrient-rich, low-oxygen deep water upwelled off the coast of Washington during the summer months. Water from the Pacific Ocean enters the Sound through Admiralty Inlet and Deception Pass. Puget Sound contains approximately 168 billion cubic meters of water, with an average tidal change of 3.7 to 4.3 meters and an average water volume exchange of 8 billion cubic meters with each tidal cycle (King County, 1994). A mixed semi-diurnal tide, which is characterized by two unequal high tides and two unequal low tides occurring each day, dominates the tidal pattern within Puget Sound. These characteristics are conducive to maintaining overall favorable water quality conditions in Puget Sound.

King County's marine water study region is located within the Central Basin extending southwest to Tramp Harbor and southeast to Normandy Park, west to

Vashon Island, and north to Richmond Beach. Elliott Bay, a large urban embayment, is also located within King County.

Water quality in Puget Sound is influenced by many complex factors, including human activities, ocean currents, and physical, biological and chemical aspects. The physical characteristics of the Sound help to maintain good water quality in King County, despite the Sound's industrial use and proximity to urban areas. Offshore water samples consistently indicate good water quality, however, nearshore sediments tend to accumulate contaminants from industrial and urban processes. Sediment carried in runoff from land plays a much greater role in the water quality of Puget Sound than in most oceanic areas. Being surrounded by hills, lakes, and rivers in an urbanized area with substantial rainfall gives the Sound a multitude of complex sediment sources. The most common sediment source is from rivers. The twelve largest rivers entering the Puget Sound estuary deliver approximately 1.8 million cubic meters of sediment annually. Their suspended load is highest during winter and early spring when heavy seasonal precipitation from winter storms erodes soil from the surrounding lowlands. Sediment sampling generally shows the highest levels of organic compounds in the nearshore areas of Elliott Bay, where urban runoff from storm drains, industrial sources, and nonpoint sources is the greatest.

WASTEWATER COLLECTION AND TREATMENT

Wastewater from homes, businesses, and industries within King County is transported through pipelines that belong to local sewer agencies and then through King County's system of much larger pipelines (interceptors) to the treatment plants operated by King County. At the plants, solids are separated from liquids. The liquids are then treated, disinfected, and discharged into Puget Sound. The solids are treated and the resulting rich organic material, known as biosolids, can be recycled and used to enrich agricultural and forest soils.

The County provides wastewater treatment and disposal services to cities and local sewer and/or water districts and more than 200 million gallons of wastewater are transported and treated each day. To accomplish this, King County currently operates and maintains two wastewater treatment plants, two

combined sewer overflow (CSO) treatment plants, 37 pump stations, and 391 kilometers of pipelines (Figure 1-1). The West Point Treatment Plant (TP) and the South Plant (formerly known as the East Division Reclamation Treatment

Figure 1-1. King County Wastewater Treatment Plant Locations

Plant at Renton) provide primary and secondary wastewater treatment. The Alki and Carkeek CSO Treatment Plants store combined flow and later pump it to the West Point TP or provide the equivalent of primary treatment and disinfection for discharges. Prior to July 1998, the Alki facility operated as a wastewater treatment plant. Following conversion to a CSO treatment facility in July, there were no discharges from this plant until November 1998. King County took over operation of the Vashon Island Wastewater TP in November 1999. Since data collection provided in this report was prior to that time, no information on the Vashon Island TP will be presented in this annual report but will be included in the 1999 annual report.

The wastewater and CSO treatment plants have outfalls that discharge directly into Puget Sound marine waters. The Clean Water Act states that all wastewater collection and treatment facilities that discharge effluent into surface waters are required to have a National Pollutant Discharge Elimination System (NPDES) permit. In Washington, the Washington State Department of Ecology (Ecology) administers this program by delegation from the U.S. Environmental Protection Agency. An NPDES permit sets limits on the quality and quantity of treated wastewater that is discharged.

The Treatment Process

The goal of the wastewater treatment process is to restore wastewater coming into the treatment plant to a level that does not adversely affect receiving waters. Treatment is accomplished by removing solids (organic matter and debris such as rocks, sand, leaves, and sticks), biodegradable organics, and pathogenic organisms.

Organic matter is a major component of the sludge (biosolids) produced when the solids are separated from the wastewater during the treatment process. However, some organic matter (activation sludge) is reincorporated in the wastewater as "starter" for the biological treatment process. Bacteria in the Sound attack and degrade organic matter and in the process consume oxygen in

the water, thereby reducing the amount of oxygen available to fish and other aquatic life. The amount of oxygen that bacteria consume is known as the biochemical oxygen demand (BOD). It is important to keep the BOD to a minimum by removing the maximum amount of organic material possible in wastewater before discharge.

In primary wastewater treatment, physical processes remove most of the floating and settleable solids. As wastewater enters the plant it passes through bar screens that catch large objects and debris, such as sticks and plastics. The wastewater then enters a grit chamber allowing sand and gravel to settle to the bottom. The material that is collected from the grit chamber is washed, dewatered, and sent to a landfill for disposal. The wastewater then moves to a series of sedimentation tanks, much like quiet ponds, that allow solids to settle out and form what is called primary sludge. Machines skim off any material, such as oil and fats, that are left floating on the surface. The sedimentation tanks remove approximately 50 to 70 percent of the solids. The primary sludge is pumped out for further treatment and recycling. Wastewater is then sent on for secondary treatment.

The secondary treatment process removes most of the remaining settleable and dissolved organic matter by biological processes. Wastewater is directed into large aeration tanks which bubble air through the water—in the same way rapids and waterfalls aerate a natural stream. Microbes (microscopic organisms such as bacteria and protozoa) are stimulated to consume biodegradable organic matter in these aeration tanks. Secondary sedimentation tanks (secondary clarifiers) are then used to allow much of the microbes, solids, heavy metals, and organic chemicals to settle out. Settling usually takes between four and eight hours. Most of these settled solids are recirculated back through the secondary treatment process and the remaining solids are combined with primary sludge and converted into biosolids. Finally, the wastewater is disinfected with chlorine before being discharged. Most of the solids and pollutants have been removed from the final effluent. Figure 1-2 shows an overview of the treatment process.

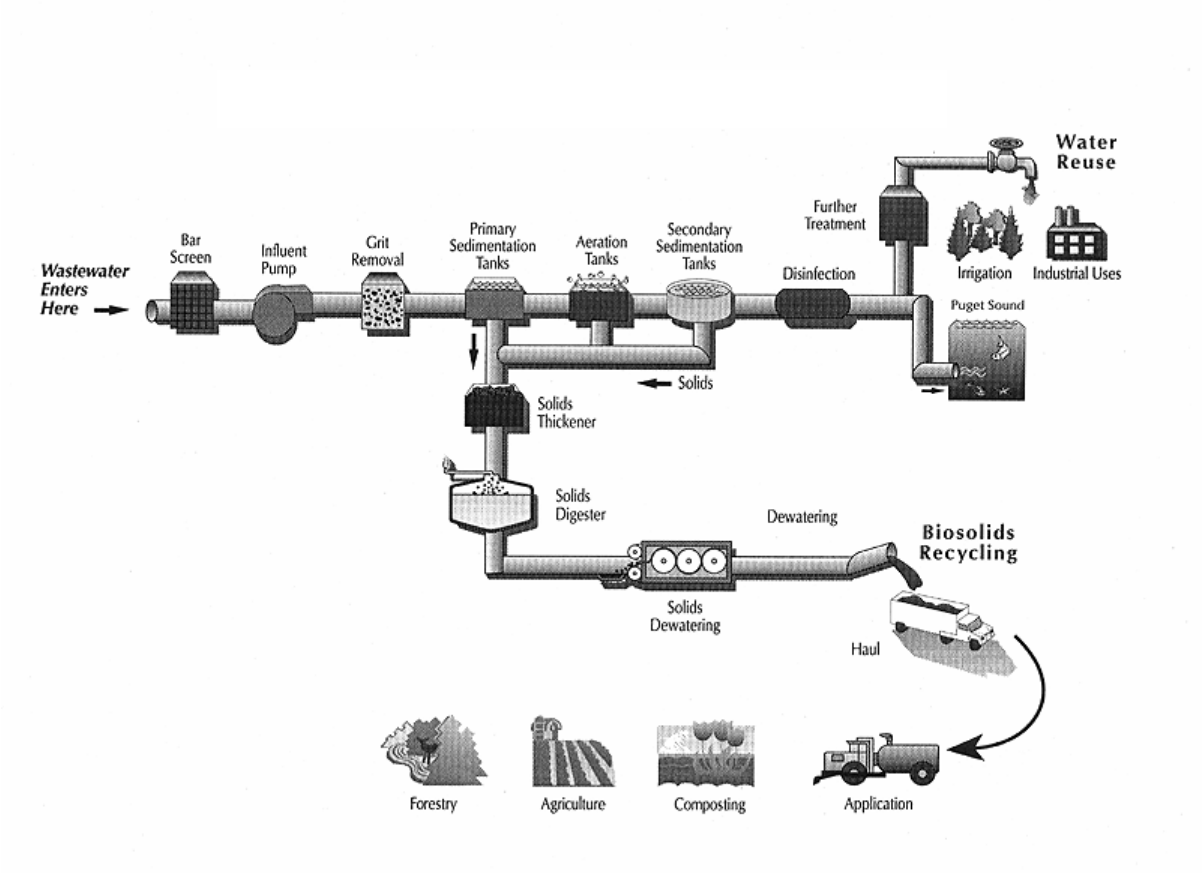

Figure 1-2. The Wastewater Secondary Treatment Process

Combined Sewer Overflows

Combined sewer systems carry both sanitary sewage and storm water runoff in a single pipe. Combining sewer systems was the standard practice until about the mid 1900s, therefore, all sewers built in Seattle from 1892 until the early 1940s were combined sewers. When new sewer systems are installed today, storm water is separated from residential, commercial, and industrial wastewater.

The City of Seattle originally built a combined sewerage system to collect wastewater and storm water for direct discharge into local water bodies following treatment. The city also built overflow pipes designed to discharge high volumes of untreated wastewater and storm water into the nearest water body during heavy rains when the storm-related flows exceeded the system's capacity. Today, remnants of the combined sewerage system are part of King County's wastewater collection system.

In combined sewer systems, trunk sewers and interceptors have fixed capacities while combined flow varies with the amount of rainfall. Consequently, during periods of heavy rain wastewater volumes may exceed the capacity of sewer pipes that transport the water to treatment plants. To prevent damage to the treatment plants and to prevent sewers from backing up into homes and businesses, combined sewers are designed to overflow at certain points. Typically, these overflows are designed so that the overflows are discharged to marine waters and rivers where the flushing action of tides and currents can disperse pollutants.

Several of these combined sewerage systems have been separated (such as the University Regulator) so that wastewater is transported to the nearest treatment plant and storm water is transported to a storm water facility before being discharged into local waters.

King County has a 600 million dollar program to lessen or remove CSO discharges. In addition to the two CSO treatment facilities (Alki and Carkeek) which capture and either store and pump the combined flow they receive to the West Point TP or treat and discharge it, there will be several additional treatment facilities built over the next 30 years which will lessen the amount of untreated wastewater entering Puget Sound waters.